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ABSTRACT

For effective educational reform, a teacher must be aware of students' views of their role in the classroom culture, and only then may a teacher assist students to become aware of their own prejudices and resistance to change in the classroom structure. This paper discusses a study that investigated the changing student role, particularly from the student viewpoint, which provides an essential description of problematic areas that teachers may address in their implementation of current mathematics education reform goals. Observed in the study were (n=52) students from two algebra classes of a teacher dedicated to changing her teaching methods, and in particular the classroom talk, from traditional interchanges to the type of discourse recommended by the NCTM Standards. Five students from each class agreed to serve as key informants and to participate in a journal exchange and interviews with the researcher. Discussion includes a summary of the students' views prior to analysis and analysis of factors that influenced students' classroom perceptions, such as the value of classroom algebra, mathematics as memorized facts, and effort and ability. Contains 26 references. (MKR)

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STUDENTS' PREJUDICES AND ALGEBRA REFORM: VALUE, ABILITY, AND SELF

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Amid recent calls for educational reform (Dossey, Mullis, Lindquist, & Chambers, 1988; Edwards, 1990; Goodlad, 1984; National Council of Teachers of Mathematics, 1980; National Research Council, 1989; Tyson-Bernstein, 1988), the National Council of Teachers of Mathematics has provided documents that serve as a framework by which mathematics program goals may be set and evaluated: *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989) and *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991). Hadley (1990) identifies the practicing teachers as ultimately responsible for the classroom implementation and evaluation of most goals described in the *Curriculum and Evaluation Standards for School Mathematics (Standards)*. However, Sarason (Sarason, 1982) suggests that teachers in general are so familiar with the way that classrooms function that they are not cognizant of the culture of the school and the complexity of students' roles in that culture.

Consistent within the study is the assumption that students in the social structure of the classroom learn rules by their individual interpretation of observed interaction and participation in that interaction. Winograd and Flores (Winograd & Flores, 1986) state:

> Any individual, in understanding his or her world, is continually involved in activities of interpretation. That interpretation is based on prejudice (or *pre-understanding*), which includes assumptions implicit in the language that person uses. That language in turn is learned through activities of interpretation. The individual is changed through the use of language, and the language changes through its use by individuals. (pp. 28–29)

Within this focus, the nature of pre-understanding that students bring to the structure of classrooms implementing the elements of reform as directed by the *Standards* and *Teaching Standards* becomes simultaneously the *good news* and the *bad news*. Classroom structure and culture compose interdependent elements of the total teaching environment, moving and changing in both transparent and opaque ways. The structure and the culture of the classroom are often simultaneously in harmony and discord. For effective educational reform, those who direct changes in the structure of the classroom must consider the culture of the classroom. In order for the culture of the classroom to be effectively addressed, a teacher must first be aware of the students' views of their role in the classroom culture. Only then may a teacher assist students to become aware of their own prejudices and resistance to change in classroom structure. Therefore an investigation into the changing student role, particularly from the student viewpoint, provides an essential description of problematic areas that teachers may address in their implementation of current mathematics education reform goals.

Choice of an Algebra Classroom

Although algebra is one of the first mathematical levels that secondary students must master in order to obtain many educational goals, recent reports suggest that many students do not acquire the minimum mathematical skills required to be productive members of our changing society (Dossey et al., 1988; McKnight et al., 1987; National Research Council, 1989). The study reported here focused at the

algebra level primarily from a realization that algebra itself is a universal theme which runs through all advanced mathematics.

Data: Methods and Implications

The sequence of methods combined in this study emphasizes the route that research may travel when the course is directed by mutual concerns established through communications between the researcher and the commonalty constituting the study: the teacher (Ms. Kay Rogers), the researcher, and the students at Custer High School (all names are fictitious). Continuous analysis of the emergence of particular topics in the data provided a basis for incorporating several research methods to optimize the information obtained in this study. By itself, no one particular method utilized in this study could provide data needed to describe the complex interaction of the students composing the observed classroom culture. Therefore, the following methods were chosen to offer a description of the multiple ways 24 young women and 28 young men in two algebra classrooms viewed their teacher's reform efforts.

Participant Observation

An "overt approach" in which research interests were public information and student cooperation was actively pursued accurately describes the field work relations established in this study (Bogdan & Biklen, 1982). This study's time frame consisted of an academic school year. Continuous observation, running field notes, and audio-taping of lessons began the first day of school and continued for six months. The observation schedule reduced in intensity during the second half of the school year. Observation continued on a regular schedule but consisted of two-, three-, and four-day units that were audio- or video-taped. A total of 75 days (150 hours) constitutes the classroom observation element of the data collected in this study. Participant observation both focused the study and provided a descriptive background.

Key Informants: Narrowing the Focus of the Study

Ten students (five from each class) readily agreed to serve as key informants and to participate in a journal exchange with the researcher. These students represented age and gender groups present within the class. This type of general approach in which the number of informants is restricted was taken from microethnography using case studies and is referred to as internal sampling (Bogdan & Biklen, 1982).

Following eight weeks of the journal exchange and five months of classroom observation, the researcher became conscious that students often exhibited explainable, if not predictable, classroom participation patterns. Questions regarding student awareness of these patterns and why these patterns had been adopted became of primary interest. Although individual students were in communication with the researcher though the dialog journals, the journals were set up with the understanding that the students would direct the topics and frequency of exchange. Rather than

change the format for the journals, individual interviews served to determine if insight into these areas of research interest could be obtained.

The key students were individually asked if they would participate in an interview; all agreed. A set of structured questions was developed to provide a framework for the forty-minute interviews. The interview structure was influenced by preliminary data analysis of classroom participation, individual journal entries, and ideas presented in *Women's Ways of Knowing: The Development of Self, Voice, and Mind* (Belenky, Clinchy, Goldberger, & Tarule, 1986).

Whole-Class: Member-Checking

Analysis of in-depth interviews, classroom observations, and dialog journals revealed several emergent themes. Although informal interviews, before and after class and during group work, provided a method for continuous verification of salient themes, an in-depth conversation with all students was not possible. An open-ended written questionnaire provided a forum through which all students in both algebra classes had a voice in affirming the salient data themes.

This information then formed the basis for a Likert questionnaire. The questionnaire's format, an introduction stem with alternate completion phrases, provided a method for ordering various categories of student responses to the open-ended questionnaire and interviews. The Likert questionnaire provided a census that determined the degree of sensitivity to key issues across the entire group of 65 students.

Key-Students and Classroom Representation

Six of the original ten key students represented particular segments of the classroom and a continuum of classroom views. The identified groups of students did not constitute well-defined sets, but formed sets with non-distinct boundaries. Major clustering factors centered on the beliefs which students held about classroom life and the role of teachers and students: beliefs about the nature of mathematical knowledge, experiential knowledge of how mathematics is learned, narrative knowledge of learning in general, and idiosyncratic ways of extending meaning to classroom events (see Walen, 1993 for further discussion). The fuzzy bounds that held the key students to their constituent groups faded and became clearer depending upon context. The following summary of six key students provides a brief introduction in order to clarify their views prior to analysis of four common belief clusters.

Jane's participation style was free and exuberant, yet she acknowledged the necessity to maintain awareness of other students' classroom needs. As she talked of her ability and her "sponge brain," she expressed pride in her grades, in her desire to go on to college, and her ability to effortlessly "soak up" mathematics. Her view of the classroom was idealized and perhaps reflected in her desire to become a math teacher. Jane met every attempt to change the structure of classroom interaction, to extend concepts, or to maximize conceptual learning with eagerness and anticipation. Jane participated in the classroom in almost the ideal manner described by the *Standards* student

communication expectations. Her specific classroom success provided a stark contrast to other students who found change difficult. In addition, her willingness to talk and willingness to think about particular aspects of the classroom was an asset to the study.

Ray appeared confident and engaged during interactions with other students in small group sessions. However, this contrasted with his aloof manner during whole-class discussions. Ray provided an interesting contrast to Jane. While they both stated they considered ability to be a primary element for success and were convinced that they had the necessary ability, Ray was not an example of an ideal student. He indicated he valued mathematics in general, but he repeatedly commented that he did not value this class in specific. He said that he had no personal commitment to learning algebra, could receive poor grades without seeing them as a reflection of his mathematical ability, and often did not participate in classroom discussions.

Fred talked about growing up on the farm and thinking that school was essential mainly for social purposes. He considered himself without the ability he thought necessary to understand algebra, but he also knew how to overcome his inability to understand. He memorized. According to him, what he memorized, he knew. This way of knowing allowed him to pass tests. Algebra was bits and pieces of memorized facts that he did not value. Since Fred did not see himself as having ability to understand, he also did not have to work for conceptual understanding. Whether he consciously recognized this was questionable.

Beth described her own assumption of a leadership role in the classroom as similar to her parents' community roles. She, like Jane, stated there were times in which other students did not approve of her participation or concern for excellence. However, Beth was unwilling to give credibility to those comments. Beth stated she knew she had the ability to learn mathematics and that she must continue to work. This combination of views allowed her to work hard when she found her ability insufficient to immediately understand a concept.

Emy often talked of how her older sister continued to remind her of the need for money to go to school. This concern for money resulted in Emy working three part-time jobs. The jobs took time away from school. Emy constantly was torn between knowing that she needed both money and good grades to go to college. She found the two mutually exclusive. The time she spent working was taken from her studies and resulted in lowered grades. Emy saw effort as the only element necessary to succeed and algebra as holding questionable value. She worked. There was never a time that she gave up on algebra. Mathematics was memorized until it became automatic, but she did not see mathematical connections. She, above all, was determined and maintained a positive attitude.

Pat viewed mathematics similarly to Emy with the exception that Pat's attitude towards algebra was expressed as frustration and anger. Pat did not direct her anger towards herself since she knew that she had succeeded previously in other mathematics classes. She put forth what she knew was the required effort and was unwilling to concede that learning algebra could require more time. She admired the teacher. Pat directed her anger towards the algebra content. While with Emy

one might assume that she may have a less difficult time in mathematics at some time in the future, Pat's anger leaves open the question of whether she will ever get beyond the anger.

Each of these six students, in their individual way, provided insight into the classroom. The following section addresses the ways in which their idiosyncratic views came together to provide a reasonable basis for their school interactions.

Present and Future Value of Algebra

The first factor discussed that influenced students' classroom perceptions was the value of classroom algebra. Schunk (1989) described students' judgments made prior to learning content regarding the necessity of the material as relevant to affective issues in the classroom. Jane, Ray, Fred, Beth, Emy and Pat all described algebra as having two distinct types of value, present and future. Value of mathematics is often noted in examining gender related differences in mathematics (Fennema & Leder, 1990). However, an expressed value of mathematics provided one impetus for students in general to spend a particularly precious commodity, time, in the acquisition of classroom mathematics.

Any school activity, mathematics included, had a value for the students in this study. Students consciously or unconsciously weighed that value against alternatives. If a particular activity was undesirable, students often chose to perform it anyway because of some perceived value or because of the consequences perceived in not performing the activity.

Jane saw school mathematics itself as important and interesting and expressed her desire to become a mathematics teacher. Jane's choice of a teaching career allowed her to enjoy equally her success in mathematics and her excitement in school. Jane's decision about what would be important to her future career in teaching concerned methods rather than mathematical content knowledge.

> This [the study of algebra] is very important, umm, like Ms. Rogers keeps telling us, it's the basis that we are going to have to have for advanced algebra, trigonometry, and all that. And I don't know, the truth is teaching methods are more fun. I like 'em.

She explained that although mathematical content was important, teaching methods were fun. Jane occasionally worried that she did not spend enough time studying. Perhaps her enjoyment of mathematics reduced her perception of the time spent on mathematics. When Jane enjoyed a particular lesson, the time went by quickly. Distinct in her vocational choice, Jane responded throughout the study with an interest in teaching methods for mathematics.

The high value that Jane placed on learning algebra was generated from both her future vocation and the daily fun the algebra class provided. Jane received enjoyment from daily class participation and from working for a long term career goal. The analysis of data suggested that such a combination of a present and a future value for algebra as a content area provided motivation for continued classroom participation and for successful transition from a traditional classroom experience to a *Standards'* classroom

Ray, however, could not tell how important algebra would be in his future. Therefore, algebra had little future value and no present value. "I'm going to worry about it [the importance of algebra] a little bit later in life. Right now I've got to concentrate on...on...I want to really sharpen my skills as best as possible, so when I get out there in the real-world, I have that much, you know, that I can do." For Ray, sharpening his skills meant thinking and questioning in general rather than in any particular content area. Learning mathematics was important, but learning algebra was not critical.

> What I will tell you is I think the situations and the problems that we are performing in this class can be worked out with an easier way of thinking. Originally the person who invented algebra, I think did it to be sort of like a hobby, not to go this far. Because this seems like everything you could figure out using simple addition or subtracting or multiplying and...and...if you could just see beyond the numbers, actually try to understand it's so much more easier. I really don't like the way it's being taught.

Ray assigned little present value to classroom algebra because he saw algebra as invented as a sort of hobby. The underlying role that algebra played in advanced mathematical and scientific processes was unknown to Ray. A vision of a future possible use for mathematics did not influence his measure of the current class. As the analysis continued, he further expanded his view of the value of mathematics in general and downplayed his current classroom performance. Ray, assured of his superior skills and ability, never acknowledged that the present was for learning. He also resented the time he thought homework took from his outside activities. Usually, activities in the current mathematics class held little value for him and cost time he would prefer spending on more challenging activities. Ray found the new format of classroom discussions quite a waste of time.

Fred did not think that the current mathematics class had value. "Algebra itself is unnecessary illogical math that someone took the time to make it sound reasonable." He did, however, think there might be a future value for mathematics if he chose to go into the family real estate business. "'Cause, you know, like square foot and stuff" would be something he might use. Fred's view of mathematics and his opinion of his own skills lead him to keep other career options open. "I was also thinking that, you know, doing other things that wouldn't require math barely at all." The value he placed on the class may relate to the future, but he would prefer not to count on its opening any doors. He, like Ray, often resented the amount of time he believed he had to spend on mathematics to obtain what he considered acceptable classroom performance.

Algebra as a subject for study held little or no value for Ray and Fred. Their measures of both present and future value did not assist them in enjoying the mathematics classroom's activities nor did it provide motivation to participate in the changing classroom structure. The teacher found the two boys difficult to motivate and expressed concern for their successful completion of the course. Through various applied activities, Ms. Rogers attempted to address issues that she felt would provide each of the boys, and other students like them, with an opportunity to see algebra as

exciting and useful, but she was seldom successful in engaging them in advanced mathematical discussions.

Beth, like Jane, thought she might pursue a career using mathematics. She expressed a future value for today's classroom mathematics. She also just liked what she knew as mathematics and therefore valued daily class sessions. Beth enjoyed mathematics and found reasons to participate similar to those expressed by Jane.

> I want to pull my sports...athletics and academics together. So I want to do something with sports medicine or physical therapy, some kind of something that I can bring them both together, 'cause those are the two things that I enjoy doing.

Her goal of a degree in medicine required knowledge of mathematical content. The values of this class tied directly to her future and spurred her towards obtaining an understanding of both mathematics and science. "I know that almost everything will deal with math if I stick to that." Within Beth's view of the value of mathematics, time spent studying both facts and concepts was well worth the effort and often paid off in good grades, yet was still a concern. Unlike Jane, who denied spending time studying mathematics, Beth felt the need to maximize the effectiveness of the time that algebra took to learn and often found herself wishing for the traditional mathematics class that required only memorized processes and not so much "talking."

For both Emy and Pat, the value of the current class divided equally between helping them get into college and not having to learn it in college. The future value algebra held for them was limited to a type of "It's easier now than in college, but if I don't get it now, I can take it then" logic. Pat expressed her view:

> I think if I do well, it will have a lot to do with what college I go to. If I know, I'll have to take these classes at college, so if I know it now and I learn it and remember it. It will be easier. It [mathematics] will have a lot to do with it [the future].

Neither Pat nor Emy wished to pursue a career dependent on mathematics. Both expressed a sort of admiration for mathematics and said that they were sure it was important. However, their interests were primarily to make the future easier and not an interest in algebra as a content area. They wished to pass the class and take the next one, so that it would be easier in college. For them, the value of algebra was limited and only in the future of an undefined career. The present demands on their time often took precedence over the future usefulness of mathematics and provided them with difficulty in motivation to decide to continue to keep up with the time consuming activities in the reform classroom. Their logic assured them that algebra had no present value. If they did not "get it" now, they could "get it" later.

One of the spoken and unspoken elements that these students used to voice their opinion about the value of mathematics was with their allocation of time. If they valued some particular topic, assignment, or project, they spent their time on it. For them, time was the essential currency of the classroom. Granted, grades concerned some students, but the primary concern was time.

Checking homework, making predictions and following up on the validity of those assumptions was real work and was time consuming. Beth's exchange with the teacher about checking all solutions to determine extraneous roots shows how time factors into practice.

Beth: You mean we have to think through all these?

Teacher: Yes, to check for extraneous roots.

Beth: Each problem will take forever.

Teacher: Well then, two problems will take two forevers.

For these students,, the time associated with the cost of learning mathematics in the new format was greater than that for memorization. Students acknowledged and articulated their particular needs and interests, made choices to value learning this particular subject, and determined the time that they were willing to expend towards that goal. Their judgment of the value of an algebra activity often evolved from a vision of a definite career choice and the perceived importance of the mathematics in the successful implementation of that career.

Mathematics as Memorized Facts and Procedures

Key informants all responded that arithmetic was memorized facts and procedures. Jane was the only one of the six that said that algebra was not memorized facts and procedures. This view of mathematics as memorized facts was best expressed by Pat.

> Math and science are exact. You know; this is the way you do it. One plus one equals two and that's just a known fact, rather than in a class like English where you get your own interpretation of whatever you are doing or you know, some of your other classes.

For her, mathematics was not a topic for discussion, it was a subject for learning known facts. Mathematics was for memorization and recall.

Table 1
Responses for 6 Target Students and 46 Non-target Students on Arithmetic and Algebra

	Likert Responses: Individual						Percent of Students (N=52)				
The arithmetic I learned in school was...	Jane	Ray	Fred	Beth	Emy	Pat	Yes!	Yes	?	No	No!
1. mostly facts and procedures that had to be memorized	Yes	Yes	Yes!	Yes!	Yes!	Yes!	29%	52%	14%	6%	0%
The algebra I learn in school is...	Jane	Ray	Fred	Beth	Emy	Pat	Yes!	Yes	?	No	No!
2. mostly facts and procedures that have to be memorized	No!	Yes!	Yes!	?	?	?	23%	40%	19%	12%	6%

Combining the views of what constituted mathematics (see Table 1) with the classroom perspectives on the value of algebra provided further insight into problematic situations within the class and resistance to permanent classroom change. The change in the classroom structure that the teacher suggested took both work and time. If a student held little or no value for algebra and saw it

only as something to memorize, then it could easily be inferred that he would not view the current teacher's attempt to encourage mathematical thinking and connections through classroom dialog as valuable or enjoyable.

Students' Views of Classroom Learning

The data suggested that these students were not only conscious of the value of learning classroom mathematics content, but they had opinions on what particular elements were necessary for that learning to be accomplished best. Students' journals and interviews provided additional data for insight into the complicating factors different self-evaluation methods brought to students' adjustments to a changed classroom structure.

Ability Versus Effort

Weiner's (1979; 1986) theory of motivation has provided a basis for the explanation of the relationship between views of success in a particular area of study and views of effort or ability in that area. However, in this study student's perception of general ability and, more specifically, mathematical ability influenced participation in the changing classroom structure. As each stage of this research provided additional insight into students' participation in the mathematics classroom, an underlying theme continued to develop. This theme concerned each individual's view of ability and effort, and how this view affected their knowledge of how they learned. The foundation of this knowledge was the amount of individual importance placed in maintaining a positive view of self. This view of self continued to be consciously and unconsciously protected throughout the discussions and classroom experiences in the data.

Students who identified mathematics as a content area requiring only effort for success responded differently to the changing classroom than those who saw ability alone or a combination of effort and ability as essential. As this discussion continues it will be helpful to identify and categorize several students' beliefs. Jane, Ray, and Fred assigned mathematical success solely to ability while Emy and Pat credited success to effort. Beth attributed success to a combination of effort and ability. These basic views were complicated by other factors that both influenced and were influenced by students' classroom participation in the changing classroom structure.

As the study progressed, Jane's knowledge of her mathematical ability became an asset that gave her the confidence necessary to adapt to the changing structure of the classroom. In her journal writing she described herself as "...always relying on my brain being a sponge and I've had pretty good luck with it but something tells me it won't last." She did not have to work to do well. Somehow that made her uneasy. Although Jane denied working hard or studying, she always completed her work and frequently participated in classroom discussions. For many students, that required hard work or study. Jane knew that she had always had mathematical ability. She attributed her success in school to that very characteristic.

> Gosh, in my case, it's got to be ability. I'm sorry. Because, you know, I don't work hard. I don't study. I don't practice a lot, golly knows I don't practice. I don't do that. In other cases I have to work hard to understand something. But most of the time it's ability to grasp what's been talked about. I think hard work can be just as influential for another person. If they work hard. For somebody that doesn't have the ability of another person, hard work goes a long way. I think also that if somebody has ability and doesn't work hard, or do anything like that it doesn't do them any good.

Jane's recognition of her ability to understand "what was talked about" was primary. No one could take that away from her. She acknowledged hard work as a substitute for success in the classroom. That, however, was "for another person" and not for her. Within her view of ability and effort, Jane believed hard work was necessary for others with ability. If they did not "work hard or do anything like that," then ability did not "do them any good." Jane described herself as both separated from and connected to the class. She considered her own ability superior to other students who had ability. Jane described her feelings upon getting the only perfect score on an exam. "I almost feel guilty because I see others having such a hard time with algebra when I have such an easy time with it." Jane denied putting forth an effort. "I don't study or take notes." This denial served to solidify her vision of her own superior ability. She was so capable that she did not have to work. Everyone else had to work for good grades, but according to Jane, grades came to her without effort. Jane's confidence allowed her frequently to view herself in the role of teacher.

Recall from previous data that Jane held a high present and future value for algebra and felt secure in her vision of algebra as more than just a process to memorize. Coupling these factors with knowledge of her mathematical ability provided Jane with pleasure, security, and confidence that allowed her to function enthusiastically in the changing classroom atmosphere.

Ray also possessed a view of himself as able. Like Jane, Ray denied working, though, unlike Jane, he truly did not work. Ray described the class and the way ability and effort influenced what he considered success in the following statement.

> Ability is...is nice to have, and I have ability and hard work is something I lack, that includes perseverance. Now the people that do not have ability go to hard work as an alternative, because there is no other way to survive. Umm...now I think that ability **could** lead to hard work, but hard work **will** lead to ability.

Ray's confidence in his own ability sustained him in his decision not to participate in the classroom. Ray could, whenever he decided, obtain academic success through a decision to start working. Recall from previous analysis that Ray found no present value and questionable future value in algebra. These factors and his view of his ability allowed him to choose not to participate in the classroom yet maintain a positive self-image. Ray considered himself "just lazy" and that was "OK."

Ray additionally saw ability as possibly leading to hard work. In other words Ray might use his ability to work hard. Curiously, Ray also saw hard work as leading to ability. For him, ability was something that he had and that others could obtain through hard work. Both Jane and Ray knew that they had mathematical ability. They knew also that ability was what it took for success. Jane and Ray also expressed that ability always had been and always would be theirs. That provided them with the option to choose whether or not they wanted to participate in school and in the changing mathematics classroom.

Fred knew that mathematical ability was necessary for success, but, when mathematical ideas were not familiar to him upon first observation, he concluded that he did not have that ability.

> If you have the ability then you **already** know it and you are able to understand it better. But hard work, although you will get to know it...even with hard work, you won't fully understand it as if you had ability.

For Fred, no amount of hard work would make up for ability. Fred therefore had a difficult task. He had to work to make up for ability that he did not have, yet no amount of hard work would create that ability. Fred had a vested interest in maintaining the status quo in the mathematics classroom. Recall that Fred did not value algebra, and distrusted mathematics. He had, however, been successful in prior mathematics classrooms, as he evidenced by his previous successful grades. He obtained this success without what he described as the necessary mathematical ability. Fred thought the new class format placed more importance on mathematical ability, something that he did not have, and was unable to acquire with any amount of effort. Change in the mathematics classroom structure was not welcome for Fred and others like him. Fred's comment included the not uncommon idea that "school mathematics" was easier to learn if you already knew it. A fragmented curriculum, in which students were expected to patiently wait until they were taught something that they were previously taught the year before, may have generated this perspective.

Beth knew she had and needed both ability and hard work for academic achievement. Beth, like others, often talked of working hard. Beth used the phrase working hard when she wanted to indicate that she put forth an effort towards learning a mathematical concept or spent what she considered a "lot of time" studying for an exam or completing an assignment. Working hard indicated an effort needed to be put forth to accomplish some goal. Within her discussions, hard work was synonymous with effort. Beth's descriptions of what it took for mathematical success inseparably coupled effort and ability. She explained:

> I think they both go hand in hand. You have to work hard, but you have to have the ability to work hard. And if you worked hard and you didn't really have the ability to remember all the clues or steps then you might not be able to put those to work.

Beth's view was that ability allowed you to work hard. Bear in mind that Beth placed both present and future value on algebra. This fact and her view of ability and effort as essential for classroom success were pivotal in describing her efforts to assist in the changing mathematics classroom.

Perhaps her connecting of these elements both drove her and allowed her to perform successfully in the academic setting of the classroom. She knew that she had ability and knew that it was important to work hard. Her acceptance of the necessity of work, her confidence in her own ability, and her self-imposed leadership role allowed her to work comfortably and even assist in redefining the classroom participation structure.

Emy, like Pat, represented those who found classroom change distressing. Emy saw only hard work as the required element for success. "Hard work. I think that anyone can learn if they work just a little bit." During this research project Emy continued to work hard, but often found herself without the means for successful comprehension of mathematical concepts, given the time she allowed for study. She, unlike Beth, could not fall back on ability when time did not allow for hard work to assist her success. A low perception of math ability influenced Emy to such an extent that she reportedly planned to fail in her first attempt at studying algebra. This was not expressed in a negative way, but rather as an acceptance of the consequences of her lack of mathematical ability. She wondered if her low ability might be genetic. "My parents say that they were never good at math either. Is this, or was this a hereditary trait?" Emy's mature nature tempered her resignation to her inability. She planned her high school schedule so she would have two years in which to pass algebra.

> I came in [to the algebra class] wanting to learn more about it because I had never really, you know, known how to do any of it. I had set some goals that I was going to know how to do it when I walked out. Then maybe take it again next year and move on to something higher the senior year.

She thought that she might learn something the first year, but she was sure that she would need two years in which to pass algebra. Emy felt she learned something even when she failed. Recall that Emy placed only limited future value on algebra, provided justification through example, and felt that effort was the only element necessary for learning. These factors did not allow for an easy transition to the current teacher's goals of establishing a Standards' classroom environment. Emy, however, had experienced past failures in traditional mathematics classrooms. Although she was not certain if she could succeed in the current class, she knew that she had failed in a traditional setting. Emy's mature nature, her past failures in mathematics, and her trust in the teacher softened her reluctance to change.

Pat considered herself capable generally and mathematically and gave evidence of this capability in her superior grades and placement in advanced classes. She named effort as the sole element that insured success.

> I think hard work, because if you work hard enough you can pretty much understand anything. I mean, if there's just a total block there's no doubt in your mind that you'll never understand it and I think that's just a negative attitude. I think if you work hard enough and you ask enough questions and try over and over again, I think eventually you can achieve it.

Pat found effort synonymous with success. The only thing that could come between effort and success was a negative attitude. Pat was confident and comfortable with her prior knowledge of how she was to learn mathematics. Pat's low future value for algebra and view of effort as the sole element required for success combined to form a source of great discomfort in the changing structure of the mathematics classroom. She had performed in the same manner that had previously given her success. The teacher was "a good teacher." Yet poor grades gave her evidence of trouble. For Pat the dialog format of the current class seemed to be the problem. She did not want to continue with that change in the classroom structure and she therefore seldom participated in the dialog.

Table 2
Responses for 6 Target Students and 46 Non-target Students on Views of Effort and Ability

	Likert Responses: Individual						Percent of Students (N=52)				
When I get a good grade in algebra it is because....	Jane	Ray	Fred	Beth	Emy	Pat	Yes!	Yes	?	No	No!
1. I study hard	No!	No	Yes!	Yes!	Yes!	Yes	15%	33%	29%	14%	10%
2. I'm just good at math	Yes!	Yes!	No!	?	No!	No	17%	17%	21%	19%	25%
When I get a bad grade in algebra it is because....	Jane	Ray	Fred	Beth	Emy	Pat	Yes!	Yes	?	No	No!
3. I didn't study hard enough	Yes!	Yes	No	No	Yes	Yes	33%	31%	17%	14%	6%
4. I'm just not good at math	No!	No!	Yes!	No	No!	?	14%	12%	17%	21%	37%
I could learn algebra easier and better if...	Jane	Ray	Fred	Beth	Emy	Pat	Yes!	Yes	?	No	No!
5. I had more math ability	No!	No	Yes!	Yes!	Yes!	Yes	37%	21%	15%	15%	12%
6. I tried harder	Yes!	Yes!	?	No	Yes!	Yes	35%	33%	21%	8%	4%
7. Some people are good at math and some just aren't	?	?	Yes!	Yes	Yes!	Yes!	40%	37%	23%	0%	0%

Table 2 presents individual student responses and the percentage of students in the two algebra classes who chose responses similar to the six selected students. Since Jane and Ray knew they were already good at math, neither of them wished for additional math ability. Their success in mathematics provided positive feedback while they assigned lack of success in mathematics to not studying hard enough or needing to try harder. This assignment of credit and blame protected their measure of their ability and ultimately their image of themselves as students. In addition it also allowed them to try new aspects of learning mathematics, since their ability remained unchanged with failure or success. A particularly interesting aspect of both Jane's and Ray's views of ability was that neither of them were sure whether some people were just good at math and some were not. This view seemed reasonable since students who regard themselves as able may not consider it possible **not** to have ability. Jane and Ray thought the ease of their learning was natural. They did not even

consider the possibility that others had "no ability" but thought there were merely "degrees of ability." Everyone had some, and in Ray's opinion hard work would definitely lead to more. From Ray's perspective, anyone could have as much as they wanted. None of the key students who considered themselves as not capable responded in the same way as Ray and Jane (see Table 2).

Upon first examination, this combination of beliefs seemed to be optimal for learning, and for Jane this may have been true. However, these beliefs provided a source of conflict for Ray. His confidence in his own ability allowed him to choose not to perform in the classroom. Reasoning that poor marks were not a reflection of his ability allowed Ray to fall behind in the class and to choose not to participate. He had no reason to worry; he could learn it anytime. This provided a trying situation for his teacher, who saw Ray as capable but unwilling to contribute to classroom discussions of mathematical ideas.

Fred attributed good grades to working hard and bad grades to just not being good at math (see Table 2). Unlike Jane and Ray, Fred wished for more mathematical ability and, unlike Jane and Ray, he was not sure if trying harder would improve his grades. Since he did not attribute bad grades to not studying hard enough, it followed that he saw trying harder of questionable value. Fred's views protected his view of himself as a student. He knew that it really took ability to do mathematics and he did not have that ability. He saw himself as hard-working. When his effort did not provide him with the expected result, the data suggests he was able to place the blame on not having any mathematical ability. In this way he was not responsible for anything that went wrong, and yet could take the credit for working hard when he was successful.

Beth saw both ability and effort as essential for success. This combination provided her with enough security to participate in the changing classroom structure and kept her working in the class. Unlike the other five individual students, Beth was not sure whether she received good grades because she was good at math (see Table 2, question 2). This was a reasonable response for her since she felt that both effort and ability were necessary. Beth did not blame bad grades on not studying hard enough, nor did she blame them on not having enough ability. Unlike Jane and Ray, who saw themselves as having more than enough mathematical ability, Beth saw herself as having some ability and working hard. For her, more ability would make learning mathematics easier. Beth recognized mathematical ability in Jane and Ray and would often defer to them in the mathematics class, though what she recognized and respected may have been no more than their aura of self-confidence.

Emy's and Pat's attribution of mathematical success to effort left them without recourse when not satisfied with their classroom performance. They chastised themselves for not working hard enough if they could not find anything or anyone else to absorb the blame. It seemed that for students with this outlook on learning, adapting to a new classroom environment was very difficult. Many students who saw their previous success in traditional classrooms as due to effort alone felt uncomfortable whenever they met any difficulty in the new classroom format.

Students' abilities to take risks and to function in new learning situations directly affected the teacher's attempt to reproduce the vision of the mathematics classroom as presented by the *Standards*. Students who were uncomfortable in questioning because maintaining their positive image of themselves required consistent classroom success had a difficult task in changing to meet the new expectations. These data suggested that students' views of effort and ability affected their view of the changing classroom.

The separation of these data into topical categories did not justly describe the complex nature of these students' decision-making processes as they participated in classroom activities. However fragmented, partitions were necessary for a clear presentation of salient issues that naturally formed around student differences in valuing mathematics, methods of establishing mathematical validity, and views of learning mathematics (effort and ability). As students identified combinations of factors, individual comments and participation in classroom discussions that at first seemed unexpected became reasonable. Finally, data suggested the particular individual student's solutions to problematic areas were additionally dependent upon their trust and belief in the teacher's expert knowledge of teaching.

The data suggested that an individual student's classroom frames gave indications of particular areas of conflict. Therefore, one may make three general statements in response to identifying areas of conflict that may arise when students are asked to participate in the *Standards'* classroom. One, students gave social reasons for participating or not participating in classroom change. Two, students who felt that they were mathematically able could take risks in classroom interaction through hypothesizing and offering mathematical justification. Three, students experienced conflicts with the nature of the value of the classroom mathematics and time.

Views of Problematic Areas and Coping Strategies

Students' measure of the present or future value for mathematics, view of mathematics, and self-perception of ability categorized changes in classroom participation as problematic or non-problematic. Coping strategies, such as non-participation and dependence on a traditional classroom interaction pattern, become reasonable when examined from a student's perspective.

Ability and Effort as Image Protection

A student's perception of general ability and, more specifically, mathematical ability influenced participation in the changing classroom structure. As each stage of this research provided additional insight into students' participation in the mathematics classroom, an underlying theme continued to develop. This theme provided a foundation for framing the amount of individual importance placed on maintaining a positive view of self. Data suggested that students' views of effort and ability affected their view of the classroom. Students' risk taking and successful functioning in new learning situations directly affected the teacher's attempt to reproduce the vision of the mathematics classroom as presented by the *Standards*.

Students who identified mathematics as a content area requiring only effort for success responded differently to the changing classroom than those who saw ability alone or a combination of effort and ability as essential. Students' views of ability and effort as essential for the learning of mathematics compounded with other classroom perspectives to allow some students to take risks. Those students who saw themselves as mathematically able and who considered ability or both ability and effort essential for classroom success took more risks in classroom interaction. For these students, making a public error had minimal effect upon what they perceived as their classroom-image and ultimately their self-image. Ability was perceived by these students as a stable element belonging to the individual, unchanged by classroom evaluations or interactions. This was consistent with Wiener's (1979) causal attribution theory in the sense that students views of their ability were less sensitive to error producing situations. However, the current study did not obtain the categorical separation of attribution leading to increased or decreased motivation as indicated by Wiener's (1979) work.

Other students who either saw ability as necessary and knew that they personally did not have the requisite mathematical ability or who saw effort as the only requirement for classroom success were less able to take classroom risks. These students were also uncomfortable in taking risks by challenging classroom mathematical processes, offering justification, or asking higher-level questions. Maintaining their positive image of themselves required consistent classroom success.

Mathematics as Memorized Fact

Students who viewed algebra as constituting memorized facts resisted the teacher's attempts to move the classroom dialog towards an interactive student centered format. They continuously requested help from the teacher while working in groups and consistently requested the teacher to give specific step-by-step solutions in whole class discussions. Pat and Fred, in particular, found listening to other students a waste of time. They, and others like them, found the class discussions particularly boring and assumed a coping strategy described by Pat.

> I get tired of kids talking. Maybe [they've] been talking about it [algebra] the whole class period, so it just kind of gets worn out, so you just kind of sit there. [Probe: What do you do when you aren't participating?] I kind of pay attention, but I kind of stare at my paper. [Probe: So you look like you are paying attention, but you're not.] Yeah.

Fred described a particularly embarrassing result of his non-participating coping strategy in the new classroom format.

> You know, I daydream, or look out the window, or something, just basically not pay attention. Sometimes I'll listen just to hear what the other people have to say about it, but then I get into a problem where I say something based on no knowledge whatsoever of the subject.

Fred often would appear to enter whole class discussions with completely unrelated comments. Fred was aware that his strategy of looking like he was interested and reentering the discussion with inappropriate suggestions was not serving him well. The strategy of "tuning in while tuning out" had

previously been successful in a traditional classroom lecture which consisted of a discussion of repeated examples of similarly structured problems. However, Fred's view of mathematics as memorized influenced his interest in other students' classroom conversations. He thought he could learn few facts from their discussions, did not wish to hear "things that would just mess you up," and often paid attention only when students he considered expert, such as Jane, offered suggestions. For many of these students classroom time was a particularly precious commodity in which they were supposed to listen to the teacher give a traditional lecture containing facts, observe and note these facts and the teacher's solution strategies, and practice the methods presented by the teacher. This guaranteed that they might become proficient in what they saw as important mathematics. It was not for listening to students.

Students' acceptance of their teacher's attempts to change their classroom assignments from many drill type problems to in-depth topic problems was also complicated by the view of algebra as facts. Students often did not attempt to do homework if the teacher assigned only one complex problem. However, these same students would complete all or most of a set of thirty or more drill-type problems. Students accustomed to successfully reproducing many similar problems in a problem set, found the idea of one in-depth problem difficult to accept. From their perspective, learning mathematics was accomplished by memorizing facts. They affirmed their understanding of a particular mathematics skill through the completion of many practice problems. One or two problems were just enough from their perspective to just get the idea of how it might be done and not to really learn something. Additionally, student logic assumed that one problem probably was not that important. In previous math classes, they had completed all but one problem on an assignment set (or missed one problem) and were informed they had done well. After all, they only missed one problem.

Students who saw mathematics as memorized attempted to assist the teacher change the classroom structure primarily from two basic viewpoints. They placed some future value on the mathematics or they trusted in the teacher's judgment that the reform classroom would ultimately serve them better than the traditional. However, placing the teacher's judgment above their own past successful experiences was often difficult for them. This teacher consistently suggested that they should make their own decisions and trust in their own views and abilities. Of course, she was suggesting this with respect to the mathematics that they were attempting to learn. However, from a student's perspective this message came across as a general message to trust themselves and their previous knowledge of classrooms which contradicted the message that indicated reform was necessary.

Summary

The teacher observed in this study was intellectually committed to the direction that the *Standards* provided. However, she was inexperienced in the adjustments required for students to meet these new demands. Both the teacher and students had difficulty in knowing how to modify the existing classroom structure, how to maintain existing changes during problematic episodes, and how to evaluate their

progress. The difficulty experienced by the teacher and students was clearly expressed by Davies (1989) in her suggestion that "the development and practice of new forms of discourse, then, is not a simple matter of choice, but involves grappling with both subjective and social/structural constraints" (p. 13). Although Davies (1989) was referring to altering discourse in general to reframe gender differences inherent in language, the teacher and students in this study found modifying their mathematics classroom discourse as difficult. The students and teacher, however willing, were faced with a difficult and long-term commitment in order for even minor change to take place.

Davies' (1989) reference to general social/structural constraints that hampered the development and practice of new forms of discourse translated to the culture of the classroom. In considering the classroom, the school forms the basis for social/structural constraints. Students' comfort with their prior mathematical knowledge and ability to learn in a traditional classroom structure previously constituted much of their learned ability to function in a classroom. Ironically, their view of prior classroom success and mathematical ability often hampered their successful participation in the changing structure of the algebra class.

Most students stated they supported the teacher's intent to change the structure of the classroom. Yet, many students found it difficult to modify their classroom behavior and expectations. The difficulty students found in adopting the changes directed by the teacher in this study were similar and yet different from adults experiencing disorientation resulting from external change as described in transition research (Bridges, 1985; Lewis, 1980; Schlossberg, 1981). Transition research suggests that adults experience transitions in three phases: ending the familiar, a period of confusion, and a new beginning. Within this structure Bridges (1985) suggests that adults in transition needed to let go of the old and familiar before new activities could be assimilated. The students in this study could not let go of their familiar classroom participation structure and expectations for two primary reasons. First, they were expected to use the familiar traditional structure for discourse in their other classes throughout the school day. Second, some lessons, or parts of lessons, in the algebra class also required students to participate in a traditional structure. Since students were required to maintain their proficiency in participating in a traditional lesson while developing the skills required to participate in the non-traditional lesson, they could not let go of the old and familiar as transition theory suggests would be necessary. Students often reacted in ways similar to their interview descriptions of traditional lessons as they encountered unexpected changes in the expected classroom structure. They also typically interpreted exceptional lessons as though they were traditional.

Implications and Future Research

This study's practical importance is based on the belief that the individual student's views of the classroom and learning classroom mathematics is essential knowledge for teachers intent upon instituting changes in the classroom. It is a view of the individual student and that individual's combination of views which mediate their classroom response to change in mathematics instruction which becomes of

value to teachers. Teachers' awareness of generalities in students' views and that individuals do not fit in those generalities but view the classroom from idiosyncratic perspectives become primary in this time of reform. A teacher may incorporate the information obtained from this study to better assist students with the transition to the *Standards'* classroom. Davies' (1982) work indicated that from the student point of view, school was not only interacting with teachers but included a child's participation in a social culture. Instructional design should consider those students who have previously been "sensitized" to particular situations , have views of mathematics which are contrary to current reform perspectives, or have particular "social agendas" which detract from risk-taking or participating in classroom discussions.

Mehan (1979) described the two "parallel cultures" of the teacher and student in the classroom. Consistent with the idea of "parallel cultures" is the idea that a teacher's agenda may indeed be counterproductive to the student's expected participation in a rather powerless traditional student culture. Therefore, a student's agenda may not include forging new classroom roles, since doing so may be counterintuitive to the traditional student culture. A teacher's expected job and a student's expected role may be the most familiar and therefore the easiest classroom roles to assume. However, consistent talk, encouragement, and sensitivity to the reasonableness of learned student perspectives may assist teachers to encourage student change in expectations. This encouragement brings forward a picture of the classroom in which students and teachers re-negotiate classroom roles. The traditional tacit negotiation between students and teachers as they interpret their classroom roles and responsibilities need not remain the modal form of communication in the nontraditional classroom. Negotiations may take a modified form. The teacher may provide a positive forum in which students may discuss or listen to others talk of their changing roles. Perhaps with a type of temporary structure guiding the transition, students may more easily make changes in their classroom learning expectations.

As the importance of students learning to "learn in a classroom" and make cognitive decisions on particular aspects of their learning (Davies, 1982; Dillon, 1988; Dweck, 1986; Mandler, 1989; Weiner, 1979) is realized, future research questions could take the form of examining what particular aspects of the classroom environment are primary in framing students' initial views of learning. If students are to assume a role in directing classroom learning through questions and justification, further work in the areas of what students view as the practical job of being a student are necessary. The student voice in the modification or the creation of the culture of the classroom must be considered. This concept of a student voice in the learning of mathematics includes the examination of practical, ethical, and moral classroom issues from their perspective.

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